

I.
THE
PRINCIPLES
OF
FORTIFICATION,
REDUCED INTO
QUESTIONS AND ANSWERS,
FOR THE USE OF
THE ROYAL MILITARY ACADEMY
AT
WOOLWICH.

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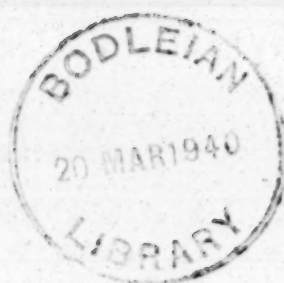
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Elementary Fortification.

PRELIMINARY NOTIONS.

A FORTIFICATION is represented on paper, by Plans, Profiles, Geometrical Elevations, and sometimes by Perspective Elevations.

Ichnography, or the plan of a Work, is its representation as it appears when cut horizontally upon the top of the foundations: it shews the length of the Lines, the several Angles, the length and breadth of the Ditches, and the different thickneses of Earth and Masonry.

Orthography, or the profile of a Work, is its representation as it appears when cut
B perpen-

perpendicularly from the highest part to the lowest : it shews the thickness, height, and depth of the several parts.

Geometrical Elevations are also called Orthography, when all the dimensions are observed to be in their proper proportions according to a scale.

Perspective Elevation is the art of drawing Buildings, Fortifications, Countries, Towns, &c. in perspective ; that is to say, with the diminutions which the rules of perspective require.

A drawing of this kind is also called Scenography, in opposition to Ichnography and Orthography, which are rightly called geometrical, in which the rules of perspective are not observed.

THE

THE
PRINCIPLES
OF
FORTIFICATION.

1st. *WHAT is Fortification?*

It is the method of surrounding a place, by Works disposed in such a manner as to form a reciprocal defence, so that a small body of men who find themselves inclosed, may resist, for some time, the attack of a greater number.

2^d. *What is the origin of Fortification?*
or, What gave rise to the art of fortifying places?

It arose from the situations in which men found it necessary to place themselves and
B 2 / families

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families for security against wild beasts, surrounding their habitations with palisades, or hedges; but soon after they had thus assembled together for mutual protection, avarice and ambition destroyed the good intelligence which at first reigned amongst them; they then began to make war upon each other, when these barriers became too weak, and gave rise to the invention of obstacles more difficult to be overcome.

3^d. *How is Fortification divided?*

Into offensive and defensive.

4th. *What is offensive Fortification?*

It is the art of conducting a siege.

5th. *What is defensive Fortification?*

It comprehends military architecture, which is the art of securing a place by Works to resist a siege.

6th. *Are*

6th. *Are there not some other divisions of Fortification?*

It is likewise divided into natural and artificial.

7th. *What is natural Fortification?*

It consists of those obstacles which naturally occur in some countries to impede the approaches of an enemy. When a place is situated upon the top of a hill, the roads to which may be easily closed up; or when surrounded with marshes, which are impassable. Such obstructions are called natural Fortification.

8th. *What is artificial Fortification?*

It consists of such Works as are constructed to defend a place.

9th. *How is artificial Fortification divided?*

It is divided into permanent and field Fortification.

10th. *What is permanent Fortification?*

It is the art of putting Towns, and other places, into a state to resist the attack of an enemy.

11th. *What is field Fortification?*

It shews the method of fortifying a Camp, Mills, Churches, Country Houses, and the construction of Tete-de-Ponts, Redoubts, Star Forts, and Intrenchments. Works of this nature are to be considered as temporary, and they exist only in time of war.

12th. *What are the principal parts of which every Fortification is composed?*

The Rampart, Ditch, and Covert-way.

13th. *What is the Rampart?*

It is an elevation of earth, and is that part of a Fortification which is situated next to the Town.

14th. *Into*

14th. *Into what parts is the Rampart divided?*

The interior slope or Talus, the body or Terre-plein, the Banquette, the Parapet, and the exterior slope or Escarp.

15th. *What is the interior slope, or Talus?*

It is the inclination of the earth, forming the Rampart, and its declivity is towards the Town. The base of this Talus is made once, or once and a half the height of the Rampart, according to the nature of the soil.

16th. *What is the Terre-plein, or body of the Rampart?*

It is the upper part of the Rampart, which remains after having constructed the Parapet.

17th. *What is the general height of a Rampart?*

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It is different according to the nature of the soil and the situation of the Works. The Rampart is usually made from fifteen to eighteen feet high, so as to cover the principal buildings, such as Magazines, Store Houses, &c. and it should always be made of a sufficient height to command the different approaches to the town.

18th. *What is the Parapet?*

It is a mass of earth elevated on the Terre-plein of the Rampart, on the side towards the country. The Parapet is made from eighteen to twenty-two feet thick, according to the nature of the soil, that the shot may not penetrate it, and from six to seven feet and a half high, to cover the troops drawn up behind it from the fire of the enemy. The top of the Parapet is formed with a declivity towards the country, which talus is called the superior slope.

19th. *Why*

19th. *Why is the superior part of the Parapet made inclining towards the country?*

In order to discover the enemy as near as possible to the place. This slope is never made more than two inches per foot, as it would otherwise weaken too much the Crest or the interior edge of the Parapet.

20th. *What is the Banquette?*

The step on which the soldiers stand to fire over the Parapet. The Banquette is made with one or two steps, according to the height of the Parapet, so that when formed, there should remain always four feet and a half of the Parapet above the upper step of the Banquette, to cover the men standing on it.

21st. *In what manner is the earth of the Rampart retained, on its exterior side?*

By

By a wall, which is called a Revetement; this Revetement is five feet thick at the top, with a slope equal to one sixth of its height. There are Counter Forts, or Buttresses on its interior side, which are constructed from fifteen to eighteen feet distant from the center to center of each other.

22^d. *Are there not some Ramparts without Revetements?*

There are some Ramparts, which are sodded or faced with Fascines; but in this case the slope is equal to the two thirds of the height of the Rampart, more or less according to the nature of the soil.

23^d. *What is the Berm?*

It is a space, or path from three to ten feet broad, between the Ditch and the exterior part of the Rampart; and when the
Parapet

Parapet is without a Revetement, there is a little Berm of two feet, which remains at the top of the Revetement of the Rampart, after having constructed the Parapet.

24th. *What is the use of the Berm?*

To prevent the earth from falling into the Ditch; and it serves likewise for the communication round the Works.

25th. *What is the Cordon?*

It is a round projection of stone, in a semicircular form, whose diameter is about one foot, placed on the top of the Revetement of the Escarp. It forms an obstacle to the besiegers, when applying ladders to the Escarp for the purpose of an Escalade.

26th. *What is understood by the Principal, or Outline?*

It

It denotes the Contour, or the line by which the first figure of the Works is defined. This line is supposed to pass along the superior part of the Cordon, from whence all the other dimensions of a work are set off, as for instance the breadth of the Rampart, Ditch, &c.

27th. *What is the Exterior Side?*

It is a line extending from the flanked angle of one Bastion to that of the next, being the side of the Polygon, on which the front of Fortification is constructed.

28th. *What is the Perpendicular?*

It is a line drawn perpendicularly from the point of Bisection of the exterior side towards the place; its length being proportionate to the extent of the exterior side and the adjacent angles of the Polygon.

29th. *What*

29th. *What is the Line of Defence?*

It is that line which extends from the Angle of the Flank to the Flanked Angle of the next Bastion.

30th. *What are the Faces of a Work?*

They are those lines which form a Salient Angle projecting towards the country.

31st. *What is the Flank?*

It is a part of a Work so disposed as to defend another; and it is that line which joins the face of a Bastion to the Curtain.

32^d. *What is the Curtain?*

It is that part of the Rampart of the body of the place, which lies between two Bastions, and which joins the Flanks thereof.

33^d. *What*

33^d. *What is an Interior Side?*

It is a line drawn from the center of one Bastion to that of the next, or the line of the Curtain produced to the two Oblique Radii of the front.

34th. *What is the Center of a Bastion?*

It is the Intersection made by the two Demi-gorges.

35th. *What is the Demi-gorge of a Bastion?*

It is the line which is formed by the prolongation of the Curtain meeting the Oblique Radius.

36th. *What is the Oblique Radius?*

It is the line drawn from the center of the Polygon to the extremity of the Exterior Side.

37th. *What*

37th. *What is the Right Radius?*

It is a line drawn from the center of the Polygon perpendicular to the Exterior Side.

38th. *What is the Exterior, or Great Radius?*

It consists of the whole Oblique Radius.

39th. *What is the Interior, or Small Radius?*

It is that part of the Oblique Radius which extends from the center of the Polygon to the center of the Bastion.

40th. *What is the Capital of a Bastion?*

It is the line drawn from the Flanked Angle to the center of the Bastion, or the difference between the Exterior and Interior Radii.

41st. *What*

41st. *What is the Escarp?*

It is the Exterior Slope of the Works.

42^d. *What is the Counterscarp?*

It is that slope which terminates the breadth of the Ditch, and is thus called from being opposite to the Escarp.

43^d. *What is meant by the Angle at the circumference of the Polygon?*

It is that Angle which is formed by the meeting of the two sides of the Polygon.

44th. *What is the Angle at the center of the Polygon?*

It is the Angle formed by two Oblique Radii.

45th. *What is the Flanked Angle?*

This Angle is formed by the meeting of two faces of a Work, which Angle is salient towards the country.

46th. *What*

46th. *What is the Angle of the Shoulder?*

It is a Salient Angle, formed by the face and the flank of a Bastion.

47th. *What is the Angle of the Flank?*

It is formed by the meeting of the Flank and the Curtain.

48th. *What is the Diminished Angle?*

It is formed by the Exterior Side and the Line of Defence.

49th. *What is the Flanking Angle, or Angle of the Tenaille?*

It is the Exterior Angle, formed by the intersection of the two Lines of Defence.

50th. *What is the Interior Flanking Angle?*

It is formed by the Line of Defence and the Curtain.

51st. *What is the Re-entering Angle of the Counterscarp?*

It is formed by the intersection of the two lines of the Counterscarp, opposite the Curtain.

52^d. *What is a Fausse-bray?*

It is a low Rampart furrounding that of the body of the place. The Terre-plein of this Work is on the level ground, or sometimes two or three feet above it; and its Parapet is about five or six toises distance from that of the body of the place.

53^d. *What is the use of the Fausse-bray?*

To augment the defence of the place, by obtaining a close and grazing fire upon the Counterscarp. But as the Faces and Flanks of this Work were exposed to be enfiladed; these parts have been omitted
in

in the late systems, and Tenailles substituted for the Curtain of the Fausse-bray.

54th. *What is an Epaulement?*

It is an elevation of earth thrown up to cover troops in flank, or sometimes in front, from the fire of the enemy.

55th. *What is the Ditch?*

It is an excavation from ten to eighteen feet deep, and from fifteen to twenty toises broad, surrounding the Rampart. The side of the Ditch next the place forms part of the Escarp, and the opposite part next the country is called the Counterscarp, which is made circular opposite to the flanked Angles.

56th. *What is the use of the Ditch?*

By increasing the height of the Escarp it serves to prevent a surprize, and adds to the difficulty of taking the place.

57th. *How many kinds of Ditches are there?*

Wet Ditches, dry Ditches, and others which are dry but may be made wet when occasion requires.

58th. *What are the advantages, or disadvantages of a wet Ditch?*

It is the best for preventing a surprize; but the quantity of bridges of communication which require continual repairs in time of a siege, and the difficulty of making sallies render this kind of Ditch inconvenient.

59th. *Is a dry Ditch preferable?*

Yes, for it can with facility be repaired, sallies may easily be made, and it is capable of containing many works proper for its defence.

60th. *What*

60th. *What advantage has the third sort of Ditch?*

It has all the advantages of the other two kinds, as it may be made wet or dry occasionally, and it is therefore to be preferred to either of them whenever it can be carried into execution.

61st. *What is the Covert-way?*

It is a space of five or six toises broad, extending round the Counterescarp of the Ditch, and covered by a Parapet from six to seven feet and a half high, having a Banquette: the superior part of this Parapet forms a gentle slope towards the country, which terminates at the distance of twenty to twenty-five toises; this slope is called the Glacis.

62^d. *What advantage is the Covert-way to the place?*

It serves to draw up troops for making sallies, which are likewise supported from the Covert-way, and this work costs less than any other in proportion to the difficulty of taking it.

63^d. *What are the places of Arms of the Covert-way?*

They are spaces contrived in the Salient and re-entering Angles of the Covert-way. The Salient places of arms are formed by the circular part of the Counterscarp and by the prolongation of the branches of the Covert-way till they intersect. The re-entering places of arms are constructed with two Faces forming a salient Angle, and drawn at an inclination of about 100 degrees with the Covert-way. The demi-gorges of the re-entering places of arms are generally from ten to twelve toises, and the Faces from fifteen to eighteen.

64th. *Of*

64th. *Of what use are the places of arms in the Covert-way?*

The re-entering places of arms are to flank the branches of the Covert-way, and to contain the troops for its defence. The saliant places of arms also serve for assembling the troops destined for the defence of the Covert-way.

65th. *What are the Traverses in the Covert-way?*

They are Parapets which cross the breadth of the Covert-way at the saliant and re-entering places of arms. Other Traverses are also constructed in the branches between two places of arms, so as the distance from one Traverse to another should not exceed about twenty toises.

66th. *What is the use of the Traverses?*

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They are to cover the troops drawn up behind the Parapet of the Covert-way, from the enfilade fire of the enemy.

67th. *What are the passages of the Traverses?*

They are openings cut into the Parapet of the Covert-way, close to the Traverses, of about six feet wide, in order to form a communication from one part of the Covert-way to another; these passages are shut by a gate when occasion requires.

68th. *What are the Sally Ports in the Covert-way?*

They are openings cut into the Glacis of the faces of the re-entering places of arms, and shut by a gate; their use is to facilitate the sallies made from the Covert-way.

69th. *What are the advantages of the Glacis?*

If

If the slope of the Glacis was to be produced towards the body of the place, it should meet the Escarp at the Cordon: it therefore covers the most essential part of the Escarp, and by being an inclined plane, towards the country, it is well seen and defended from the several Works of the body of the place.

70th. *What is the second, or advanced Ditch?*

It is formed by producing the superior slope of the Glacis.

71st. *What is the second Covert-way?*

When a second, or advanced Ditch is constructed, there is also a second Covert-way, which is made parallel to the first; its Terre-plein is lower by one and a half, or two feet; and it has a Banquette proportionate to the height of its Parapet, which is
formed

formed in a Glacis in the same manner as that of the first Covert-way.

72^d. *Why is the second Covert-way made lower than the first?*

That the superior slope of its Glacis may be discovered from the first covert-way.

73^d. *What is the use of the second Covert-way?*

It has the same advantages as the first; and by extending so far into the country, it serves to keep the enemy at a distance, and renders his approaches more difficult: it also considerably augments the strength of a place; because after the enemy has taken it, he has still the usual obstacles to overcome.

74th. *What are the Palisades?*

They are stakes of strong split wood of about nine feet long, fixed three feet deep into



into the ground, and about three or four inches asunder: they are placed in a row in the Covert-way close to the Parapet, and sometimes at three feet from it: Palisades are also placed upon the Berm of a Rampart with half Revetement, or in the middle of dry Ditches.

75th. *What is their use?*

To prevent the garrison from being surprized.

76th. *What are the Fraises?*

They are a kind of palisades placed horizontally in the Exterior Slope of Ramparts with half Revetements on the level of the Terre-plein produced; and when the Escarp is without Revetement, there should be a second row of Fraises planted, at the distance of eight or nine feet above the bottom of the Ditch.

77th. *What*

77th. *What is termed the Body of the Place?*

The Works immediately next to, and furrounding the town; in the form of a Polygon, whether regular or irregular, and composed of Bastions joined by Curtains.

78th. *What are Bastions?*

They are Works saliant to the Angle of the Polygon, composed of two Faces and two Flanks; the Bastions are joined by a line which is called the Curtain.

79th. *Why are Bastions constructed Saliant and with Flanks?*

In order that the whole Escarp may be discovered from some part or other of the Body of the Place, and that a reciprocal defence may be obtained.

80th. *What*

80th. *What are the different kinds of Bastions?*

Full Bastions, Empty Bastions, Bastions with Orillons, Flat Bastions, Detached Bastions, Demi-Bastions, and Tower Bastions.

81st. *What is a Full Bastion?*

When the Terre-plein, or Body of the Rampart occupies all the Interior Space of the Bastion.

82^d. *What is an Empty Bastion?*

When the Terre-plein and Interior Slope of the Rampart is parallel to the Faces and Flanks, and consequently leaves an empty space towards the center.

83^d. *What is a Bastion with Orillons?*

When the Faces are produced at the Angle of the Shoulder, in the form of a
Semi-circle,

Semi-circle, occupying about seven toises of the Flanks, and the rest of which is made Concave.

84th. *What is the use of the Orillon?*

To cover the Flank, and to conceal a gun which may see the breach of the Collateral Bastion, without being itself to be dismounted otherwise than by Shells.

85th. *What is the advantage of the Concave Flank?*

It gives a converging fire for the defence of the passage of the Ditch, and the breach of the opposite Bastion. It contains, by its convexity, more guns and a greater space for working them, than if the Flank was a strait line; and further it can never be enfiladed in its whole length.

86th. *What*

86th. *What is the Reverse of the Orillon?*

It is a line five toises in length, joining the Orillon to one extremity of the Concave Flank. There is generally a passage made through the Reverse of the Orillon, at the bottom of the Ditch: this passage is called a Sallyport, or Postern.

87th. *What is the Brisure of the Curtain?*

It is the prolongation of the Line of Defence from the Angle of the Flank, towards the Capital of the Bastion; this prolongation is five toises in length, and joins the extremity of the Concave, or Retired Flank, opposite to the reverse of the Orillon.

88th. *What is a Flat Bastion?*

It is that which is constructed upon a Right Line, and whose Demi-gorges do not form an Angle.

89th. *What*

89th. *What is a Detached Bastion?*

It is that which is separated by a Ditch from the Body of the Place, such as the Counterguards with Flanks, constructed by Vauban, in his second and third system, to cover the Tower Bastion.

90th. *What is a Demi-bastion?*

It is that which has one Face and one Flank, cut off by the Capital; they terminate the head of a Horn, or Crown-work.

91st. *What is a Tower Bastion?*

It is a small Bastion, constructed by Vauban in his second and third systems; the top, or platform of the Tower Bastion is two feet higher than the Terre-plein of the Rampart of the Curtain: underneath its platform are Casemates, to contain four pieces of Cannon, two in each Flank.

92^d. *Are*

92^d. *Are large Bastions to be preferred to small Bastions?*

Large Bastions with good Revetements are best; because they contain more troops, cannon and mortars, than the small Bastions: the enemy always attack the Bastion, as being the weakest part of the Body of the Place; but when it is well intrenched, this defect is in a great measure removed.

93^d. *Are intrenchments in a Bastion so advantageous to the Place?*

They are so essential in a besieged Place, that without them the proper resistance cannot be made against an assault.

94th. *In what kind of Bastions can the best intrenchments be constructed?*

Full Bastions are preferable for being intrenched, by a Work at the Gorge, or by a Cavalier, whose Faces are made parallel

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to

to those of the Bastion, at the distance of fifteen toises, and its Flanks at the distance of twelve toises, having a Ditch of five toises.

95th. *What is the length given to the Faces of Bastions?*

From thirty-five to sixty toises.

96th. *What length is given to the Flanks?*

From twenty to thirty toises.

97th. *What should be observed in constructing the Flanked Angles?*

That they should neither be too acute nor too obtuse. When the Flanked Angle is acute, it ought to be at least 64 degrees; if it was less, it would easily be destroyed by the batteries of the enemy.

98th. *What inconvenience arises from the Flanked Angle being too obtuse?*

The

The Faces of the Works would be too much exposed to the direct fire of the enemies batteries; the Flanked Angles should not exceed 100 degrees; but the best opening to give to these Angles is from 85 to 95 degrees.

99th. *What is a Dead Angle?*

A Re-entering Angle is said to be a Dead Angle when it cannot be seen or defended from any part of the Works.

100th. *What is the length of the Curtain?*

From 70 to 80 toises.

101st. *What is to be done if the Curtain should be too long?*

A flat Bastion, called a Moineau, should be constructed on the middle of the Curtain; sometimes it is separated by a Ditch, and is then called a detached Bastion: this

Work is not raised so high as the rest of the place.

102^d. *In what manner is the length of the Curtain to be determined, the height of the Flanks being given?*

By the following proportion; as the perpendicular depression of the superior slope of the Parapet of the Flank is to its horizontal thickness, so is the height of the Rampart, including the Parapet, to the distance of half the Curtain, which being doubled will give the whole length of the Curtain; and in the same manner the height of the Flanks may be determined, when the length of the Curtain is given.

103^d. *What is meant by a front of Fortification?*

It is a portion of the body of a place, consisting of two half Bastions and a Curtain.

104th. *What*

104th. *What are Barbet Batteries?*

They are Platforms elevated at the Flanked Angles of the Bastions and Ravelins, from which the cannon fire over the Parapet.

105th. *How are the Batteries in the Flanks of the Bastions constructed?*

The Platforms are not made higher than the Terre-plein, and there are openings cut in the Parapet, which are called Embrasures, for the cannon to fire through; the part of the Parapet which remains between two Embrasures, is called a Merlon.

106th. *Is there not sometimes a Battery constructed in the Curtain to defend the Face of the Bastion?*

When the Face of the Bastion can be discovered from a part of the Curtain, which is then called an oblique or second Flank, a Battery is constructed.

107th. *Are not Batteries sometimes constructed under those of the Rampart of the Flanks?*

Some Flanks have casemates, or vaulted Batteries formed in them, which are bomb proof, and the Embrasures for the guns are cut through the Revetement: the particular use of these Batteries is to defend the passage of the Ditch.

108th. *What are the Loop Holes?*

They are oblong holes, about 8 inches long, 6 inches wide within, and 2 without, cut through masonry or timber, for the service of small arms.

109th. *What is the Tenaille?*

It is a work constructed upon the lines of defence before the Curtain; it is never higher than the level of the ground, and there are circumstances in which its Terrepain

plein is made 1 or 2 feet lower than that level; it has a Parapet of 6 or 7 feet high, and from 12 to 15 feet thick.

110th. *What is the use of the Tenaille?*

It serves to augment the defence of the Ditch; the fire from this Work is more effectual than that from the Flanks, being more horizontal and nearer.

111th. *What is a Caponniere?*

It is a passage across the Ditch, opposite the Curtain, from 20 to 25 feet wide, and covered on each side by a Parapet of 6 or 7 feet high, terminating in a slope or Glacis of 10 or 12 toises.

112th. *What is the Cunette or Cuvette?*

It is a small Ditch from fifteen to twenty feet broad, made in the middle of a dry Ditch, to drain off the water from the

place. When there is a Cunette there should be a Caponniere to flank it.

113th. *What is a Batardeau?*

It is a solid piece of masonry of seven or eight feet thick, which crosses the whole breadth of the Ditch, opposite the Flanked Angles of the Bastions, upon the line of the capital produced; the top of the Batardeau ought not to be more than four feet above the surface of the water; it terminates in an edge, or roof, upon the middle of which is constructed a little round Turret of six or seven feet in diameter, and about five feet higher than the Batardeau, with a conical top.

114th. *What is the use of the Batardeau?*

To retain the water in those parts of the Ditch required to be inundated.

115th. *What*

115th. *What is a Ramp?*

It is a road cut obliquely in the Interior Slope of the Rampart, as a communication from the town to the Terre-plein.

116th. *What is a Postern, or Sally-port?*

It is a passage constructed under the Rampart; which serves to communicate from the town into the Ditch.

117th. *What communication is there from the Ditch into the Covert-way?*

By little stairs, called Pas-de-fouris, made in the circular parts, and in the re-entering Angles of the Counterscarp.

118th. *In what manner is the communication formed from the town into the country?*

A gateway is constructed in the middle of the Curtain, with a bridge extending to the Out-works, and from the Out-works
to

to the Covert-way; each bridge has a part of it contrived to draw up occasionally: passages are formed in the line of the communication through the Ramparts of the Out-works, and from the Covert-way through the Glacis.

119th. *What is a Portcullis?*

It is a sliding frame of timber or iron, in the shape of a harrow, hung over the gate, to be let down in case of surprize, or when the outer gate is forced; this machine is also called a Herse.

120th. *What are the Orgues?*

They are separate beams of wood, placed vertically over the gate, to be let down when occasion requires; these beams are of a considerable length, so that when resting on the ground, if one should be cut, or broken, it will still fall lower and fill up
the

the space. This contrivance is preferable to the Portcullis, for stopping up a gateway.

121st. *What is the length of the Line of Defence?*

From 120 to 140, or at most 150 toises.

122^d. *What is the difference between the Line of Defence Razant or Grazing, and the Line of Defence Fishant or Plonging?*

The Line of Defence Razant is when the Face of the Bastion produced meets the Angle of the Flank: the Line of Defence Fishant is when the Face of the Bastion produced falls on some part of the Curtain. In the first case, the fire from the Flank grazes the Face of the Bastion to be defended; and in the latter construction, that fire forms an Acute Angle with the Face of the Bastion, and therefore becomes Plonging.

123^d. *What*

123^d. *What is understood by a Direct Fire, or Defence?*

When the Line of Fire is perpendicular to the Parapet.

124th. *What is termed an Oblique Fire, or Defence?*

When the Line of Fire is Oblique to the Parapet.

125th. *In placing a Battery, is the Oblique, or the Direct Fire to be preferred?*

The Direct, or Perpendicular Fire is preferred, and for this purpose the Battery should be placed parallel to the Object, against which its fire is required. This rule should particularly be observed with regard to Parapets intended for musketry, as the soldiers are apt to fire directly before them, without taking aim.

126th. *What*

126th. *What is understood by Out-works?*

They are Works constructed beyond the Ditch of the Body of the Place; such as Ravelins, Counterguards, Hornworks, Crownwork, Lunettes, Tenaillons, Bonnets, Simple and Double Tenailles, Redoubts, Detached Lunettes, Fleches, or Arrows and Patees.

127th. *What is a Ravelin, or Demi-lune?*

It is a Work constructed opposite the Curtain, composed of two Faces which form a Saliant Angle towards the country, and of two Demi-gorges formed by the Counterfcarp.

128th. *What is the use of the Ravelin?*

To cover the Curtain, the Gates, and the Flanks of the Bastions.

129th. *What is the Traverse in the Ditch?*

It

It is a Work constructed in the dry Ditch of a Ravelin, to augment its defence. It consists of a Parapet, which is perpendicular to the Faces of the Ravelin; this Parapet is elevated three feet above the bottom of the Ditch, which is there sunk three feet more: the Superior Slope of this Parapet is formed into a Glacis, as that of the Caponniere.

130th. *What is the Redoubt in the Ravelin?*

It is a Work, whose Faces are parallel to those of the Ravelin, at the distance of 15 or 16 toises; it has Flanks of seven, or eight toises, to contain two pieces of cannon, to fire into the breach of the Collateral Bastions. And the Redoubt further serves as a retreat for the troops which defend the Ravelin; also to check the enemy, should they endeavour to establish themselves there.

131st. *What*

131st. *What is a Counterguard?*

It is a Work composed of two Faces forming a Saliant Angle, and constructed before the Flanked Angle of a Bastion; the Faces of which it covers, as also the Flanks of the Collateral Bastions; so that the enemy cannot batter them, without being first master of this Work.

132^d. *What is a Hornwork?*

It is a Work composed of two half Bastions and a Curtain, with two long sides, called Branches, or Wings, directed upon the Faces of the Bastions, or Ravelins, so as to be defended from them. This Work is placed before a Bastion, or before a Curtain, and serves to inclose any buildings which could not be brought within the Body of the Place, or to occupy a piece of ground which might be of advantage to the enemy.

133^d. *What*

133^d. *What is a Crownwork?*

It is a Work composed of a Bastion between two Curtains, which are terminated by half Bastions. This Work is joined to the Body of the Place by two long sides, and is placed generally before a Curtain; but sometimes before Bastions, which should command and enfilade the Branches. The Crownwork is adopted for the same purposes as the Hornwork.

134th. *What are Lunettes?*

They are Works constructed on each side of the Ravelin, one Face being perpendicular to that of the Ravelin, taken at one half, or one third from the Flanked Angle, and the other Face, nearly perpendicular to that of the Bastion.

135th. *What are Tenaillons?*

They are Works constructed on each side of the Ravelin nearly similar to the
Lunettes,

Lunettes, differing only in this respect, that one of the faces of the Tenaillon, is formed by producing the face of the Ravelin, the other face is directed to the face of the Bastion in the same manner as the Lunettes.

136th. *What is a Bonnet?*

It is a work constructed between the Lunettes, to cover the flanked Angle of a Ravelin; it consists of two Faces, which are defended from those of the Lunettes.

137th. *What sort of Tenailles are those which are constructed beyond the Ditch?*

They are of two kinds; the simple or single Tenaille, and the double Tenaille. The single Tenaille consists of two Faces, forming a re-entering Angle; the double Tenaille is composed of two single ones. They are placed before a Bastion, or a Cur-

E

tain,

tain, and are joined to the body of the place by Branches.

138th. *What is a detached Redoubt?*

It is a small inclosed work situated beyond the Glacis, and constructed of various forms. It serves to occupy some particular spot of ground that might prove of advantage to an enemy, likewise to keep him at a distance, and impede his approaches.

139th. *What is a detached Lunette?*

It is a kind of small Ravelin, whose Faces are from thirty to forty toises; constructed beyond the second ditch, before the re-entering places of arms.

140th. *What is a Flech, or Arrow?*

It is a work extending along the foot of the Glacis, before the re-entering places of arms: it consists only of a Parapet, which
forms

forms a Salient Angle, and is eight feet high: this work has a communication with the Covert-way, cut through the Glacis.

141st. *What is a Patee?*

It is an inclosed work of an irregular form, placed between two other works, to connect their Defences, and to preserve the communication between them.

142^d. *What is meant by a Command?*

When one place is higher than another, it is said to command it. A single Command, is when the height of one place above another is about nine feet: it is called Double Command, if eighteen feet higher; if twenty-seven feet, it is triple, and so on.

143^d. *How are the several Commands distinguished?*

There are three forts; a Command in Front, in the Rear, and by Enfilade.

144th. *What is a Command in Front?*

When any eminence is directly facing the work which it commands, it is said to be a Command in Front.

145th. *What is a Command in the Rear?*

When any eminence is directly behind the work which it commands, it is called a Command in the Rear, or in Reverse.

146th. *What is a Command by Enfilade?*

When an eminence is situated in the prolongation of any line of a work, and a considerable part of it may be seen from thence, that line is said to be subject to a Command
by

by Enfilade; and such a command is the most dangerous.

147th. *How are the Effects of a Command by Enfilade to be prevented?*

By raising the Saliant Angles of the works exposed to such a Command, or by erecting Traverses at proper distances.

148th. *What is meant by Defilement?*

It is the art of disposing all the Works of a Fortrefs in such a manner, as that they may be under the Command of the Body of the Place. It also includes the relative disposition of the Works, and the Ground within cannon-shot, so that the one may be discovered, and the other not seen into.

149th. *What is understood by a Plan of Comparifon?*

It is a Geometrical Plan of a Fortrefs and the Country surrounding it within can-

non-shot; on which is expressed the different Levels of every principal point: this plan is also called a *Horizontal* or *Level Plan*, and it serves to regulate the *Defilement* of a Place.

150th. *What is a Citadel?*

It is a Fortrefs joined to the Works of a place, and is fortified as well towards the town as towards the country. A Citadel should be always situated on the most commanding ground, and it serves to keep the inhabitants in awe, and should the town be taken, it becomes a retreat for the garrison.

151st. *What is an Esplanade?*

It is a space of even ground, clear of buildings, situated between the town and the citadel, so that no one may approach it from thence unperceived.

152^d.

152^d. *How is the first System of Mr. de Vauban divided?*

Into three, viz. the Little, Mean, and Great Fortification. The Exterior Side of the Little Fortification is from 120 to 175 toises; the Mean from 175 to 185, and the Great from 185 to 260.

153^d. *In what case is the Little Fortification adopted?*

It is used in the Construction of Citadels, and Forts of four or five sides, also in Horn and Crown-works.

154th. *In what case is the Mean Fortification employed?*

For all sorts of Towns.

155th. *On what occasion is the Great Fortification made use of?*

It is never adopted for all the sides of a place ; but only for a long Side, towards a River, or a Marsh.

156th. *What Dimensions are usually given to small Forts ?*

The Exterior Side is from 80 to 130 toises ; the Perpendicular one-eighth, and the Faces two-sevenths of the Exterior Side.

157th. *What is understood by fortifying Inwards ?*

It is when the Outline of a Front is constructed on the Exterior Side, and falls within the Polygon.

158th. *What is meant by fortifying Outwards ?*

It is when the principal, or Outline of a Front is constructed on the Interior Side, and falls without the Polygon.

159th. *What Length is to be given to the Perpendicular and Faces of a Square?*

The Perpendicular is equal to one-eighth, and the Faces to two-sevenths of the Exterior Side.

160th. *What Length is to be given to the Perpendicular and Faces of the Pentagon?*

The Perpendicular is one-seventh, and the Faces two-sevenths of the Exterior Side.

161st. *May not the Square and Pentagon be fortified outwards?*

Yes; and in this case the Demi-gorges are made equal to one-fifth, and the Capitals of the Bastions equal to one-third of the Interior Side.

162^d. *What Length is to be given to the Perpendicular and Faces of Polygons of more than five Sides?*

The

The Perpendicular is equal to one-sixth, and the Faces are equal to two-sevenths of the Exterior Side.

163^d. *What Effects are produced by lengthening or shortening the Perpendicular?*

By lengthening the Perpendicular, the flanked Angles are diminished; and by shortening it, those Angles are increased. When the Exterior Side exceeds 185 toises, the Perpendicular must be shorter than the general proportion of one-sixth; otherwise the Ditch would be too wide, and the Flanks too long: besides, if the Angle of the Polygon should be less than 100 degrees, the flanked Angle would become too acute.

164th. *What is meant by Irregular Fortification?*

It is the art of fortifying a place of an irregular figure, situated where the country

try

try does not admit of giving to the several works their due proportions according to rule ; and sometimes Irregular Fortification is applied to places surrounded by ancient walls and towers.

165th. *How many cases are there of Irregular Fortification?*

First, when the Angles of the Polygon are not equally distant from the center ; secondly, when some of the Angles are too acute, and others re-entering ; thirdly, when some of the sides are too long, and some of them too short ; and lastly, when both Angles and Sides are irregular.

166th. *What are the principal Rules to be observed in Irregular Fortification?*

If an irregular place cannot be reduced to a regular figure, still the Rules of Regular Fortification should as much as possible
be

be observed, that is to say, the flanked Angles should not be less than 64 degrees, the lines of defence should not exceed musquet-shot: the Sides should be lengthened, or shortened so as to obtain sufficient space for a well-proportionate front upon each, and the Length of the Curtains should correspond with the Height of their Collateral Flanks.

167th. *What are the two general Methods of fortifying Irregular Places?*

After an irregular place has been reduced into the form of a Polygon, parallel lines are drawn at about fifteen toises distant from the houses, to give a sufficient space for the Rampart; these Lines are the Interior Polygon, which may be fortified outwards, by setting off the Demi-gorges of the Bastions, and raising their Flanks at an Angle of 100 degrees with the Curtain; or the

the Exterior Side may be found and fortified Inwards.

168th. *How is the Exterior Side to be found, the Interior being given?*

By Tables calculated for this purpose, or by a general method, which is to draw a Parallel to each of the interior sides. If the adjacent Angle is that of a Square, the distance of the Parallel should be forty toises; if the Angle is that of a Pentagon, the distance is to be forty-five toises; and when the Angle is that of a Polygon of more than five sides, fifty toises should be the distance from the interior to the exterior side.

169th. *How is an Irregular Place to be fortified, about which a Regular Polygon may be described?*

A Circumference is described passing through the three most distant points from each

each other; and this circumference is afterwards divided into Lengths from 175 to 185 toises, which will give the Polygon to be fortified.

170th. *How is an Irregular Place fortified, whose Length considerably exceeds its Breadth?*

By describing an Oval about it, which may be done by drawing a Line lengthways through the middle of the place, and having found by measurement the number of sides best suited to its general figure, if a Heptagon, Hexagon, or Pentagon, 75, 77, or 80 toises are to be added to each end of this line, upon which an Oval is then to be constructed for containing the Polygon required; 70 toises only are to be added for Polygons of more than seven sides.

171st. *How is a long Side of 185 to 260 toises to be fortified?*

The Perpendicular is to be diminished from 30 to 20 toises, and the Faces of the Bastions should then be from 50 to 60 toises.

172^d. *How is a long Side from 280 to 340 toises to be fortified?*

From the Extremities of the given Side as Centers, and with a Length of 180 toises, two Arcs are described, intersecting each other towards the country; by which means the given long Side may be covered by two Fronts.

173^d. *How is a long Side from 360 to 520 toises to be fortified?*

It should be divided into as many Parts from 175 to 185 toises each, as the Ground and other circumstances will permit; and it may then be fortified by flat Bastions.

174th.

174th. *How is a re-entering Acute Angle to be fortified?*

If the Angle exceeds 60 degrees at the extremities of its two sides, Bastions should be constructed, whose Faces are to be defended from the Sides of the re-entering Angle; but if it should be less than 60 degrees, the space included between its Sides should be shut up by a Right Line, or the two adjacent Sides should be produced till they meet.

175th. *How is a re-entering Obtuse Angle to be fortified?*

By a Platform; or if the Angle should be very obtuse, by a Flat Bastion.

176th. *How is a short Interior Side from 100 to 115 toises to be fortified?*

By subtracting from the given side the Length the Curtain ought to have, and
Half

Half the Remainder will be for each Demi-gorge of the Collateral Bastions.

177th. *How is a short Side not exceeding 90 toises, to be fortified?*

When the Angle formed by producing the two adjacent Sides is not less than 100 degrees, a Bastion may be constructed upon it.

178th. *How is a Place to be fortified, having a River running through it?*

The Polygon surrounding the place should be so disposed that the River may pass through the middle of a Curtain. If the River should be as broad as the Curtain is long, Piles, or other obstacles are to be placed in it, leaving only a passage for boats or vessels, which can be occasionally shut up, by a Boom or Chain. Batteries

F

are

are also to be constructed on each Side, to defend the passage by a cross fire.

179th. *How is a Place to be fortified which is situated upon a Hill?*

Exclusive of the Fortification immediately surrounding the town, such advanced Works must be constructed as may be requisite to command the Approach to the place, and to see into any Hollows that cannot be discovered from thence; these detached Works must be so disposed as to be properly defended from some part of the Body of the place.

END.

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